DISCUSSION

Magnetic resonance (MR) imaging plays a crucial role in the assessment of epiphyseal disorders by demonstrating cartilaginous and osseous structures in great detail without the use of ionizing radiation. Magnetic resonance (MR) imaging can be used to evaluate vascularity, marrow, and cartilage and plays a critical role in the assessment of epiphyseal disorders. In cases of hip dysplasia, MR imaging demonstrates un-ossified structures and helps to guide treatment. In cases of trauma, the intra-cartilaginous pathway of fractures and the degree of epiphyseal involvement can be assessed with the use of intravenous gadolinium-based contrast material, avascular necrosis and reperfusion can be characterized[(94)].

This study included forty patients, twenty two females (55%) and eighteen males (45%), their ages ranged from 4 to 65 years with a mean age of 35 years who underwent MRI hip scan for assessment of complaint. Those 40 patients were classified according to MR findings;(12 patients(30%) with avascular necrosis, 6 patients (15%) with osteoarthritis , 4patients (10%) with migratory osteoporosis,4 patients (10%) with septic arthritis, 5 patients (12.5%) with developmental dysplasia, 4 patients (10%) with Perthe's disease, 3 patients (7.5%) with slipped capital femoral epiphysis and 2 patients (5%) with stress fractures.

Magnetic Resonance Imaging (MRI) is the most sensitive and specific imaging technique for evaluating avascular necrosis of the femoral head in early/precollapse stage[(95)].

MRI has several advantages, allows accurate staging by clearly depicting the size of the lesion, it also detects asymptomatic lesions that are undetectable on plain radiographs, thus facilitating early treatment and better response. It provides multiplanar imaging and excellent soft tissue resolution and can demonstrate response of the femoral head to treatment[96].

Out of the 12 patient diagnosed as avascular necrosis, the disease was bilateral in (6) 50% of patients and unilateral in the remaining (6) 50 % of patients and this is in agree with Hamilton, T. W. et al.[97] as they reported that it is important to evaluate the contralateral hip, as bilateral involvement has been reported to be between 40% and 80%.

Manenti et al.[98] reported that (65–85%) of patients of avascular necrosis, show a characteristic “double line” sign on T2 weighted images which is characterized by an outer low signal of intensity rim with an inner zone of high intensity referred to the granulation tissue, and this is agree with our study that showed the characteristic “double line“ sign on T2 weighted images in 9 patients (75%).

In our study, The dominant MRI finding was focal subchondral signal abnormality which was identified in all the 12 (100%) patients, followed by the double line sign (serpiginous hypointense line surrounding area of the head with altered marrow signal) that was identified in 9 (75%) patients, bone marrow edema in 6 (50 %) patients and joint effusion in 3 (25%) patients.

In our study, The MRI findings of AVN were true positive in 10 patients, false positive in 2 patients and the sensitivity of MRI

in diagnosis of avascular necrosis was 83.3 % and this is in agree with Glickstein MF et al.[99] as they reported that MRI is the most sensitive modality in diagnosing AVN, with a sensitivity of 71-100% and specificity of 94-100%.

There are many classification systems that describe the clinical and radiological severity/progression of AVN. Ficat and Arlet-staging system is still one of the most commonly used systems. It is based on radiological findings, but does not consider the extent of necrosis. Steinberg et al.[100] added quantification of femoral head involvement to the classification system, but could not gain wide popularity as it was difficult to apply. The Association Research Circulation Osseous (ARCO) system of classification incorporated features of both Ficat and Arlet system and the Steinberg classification[101].

The 12 cases of our study who had avascular necrosis were classified according to degree of affection(2 patients with stage 1 AVN,4 patients with stage 2,3 patients with stage 3 and 1 patient with stage 4).

Osteoarthritis (OA) is a heterogeneous and multifactorial disease characterized by progressive loss of hyaline articular cartilage and development of altered joint harmony, subchondral sclerosis, intraosseous cysts, and osteophytes. Hip OA is a crippling disease and a major public health problem[102].

Teichtahl et al.[103] suggest that structural MRI abnormalities are present prior to clinical hip OA, and that cartilage defects and bone marrow lesions (BMLs) in the anterior and central superolateral regions identify early structural changes of hip OA and may be potential therapeutic targets for the prevention and early treatment of hip OA.

Hayashi et al.[104] reviewed that Subchondral bone marrow lesions are a common imaging feature of OA with clinical significance and typical signal alteration patterns.

The hip is frequently involved in acute inflammatory disorders such as rheumatoid arthritis, seronegative spondyloarthropathies, and juvenile idiopathic arthritis. Conventional radiography is still the mainstay for diagnosis of hip joint damage and subsequent follow-up, but it is now recognized that magnetic resonance (MR) imaging is very sensitive imaging method for the detection of articular and paraarticular involvement[105].

Once joint space narrowing is recognized, the presence of bone erosions suggests an inflammatory arthritis, while osteophytes indicate a degenerative arthritis. The joint distribution and the presence of bone proliferation allow distinction between septic arthritis, rheumatoid arthritis, and the seronegative spondyloarthropathies[106].

Bony erosions are seen well using MRI in early rheumatoid arthritis and are frequently detected before they appear on plain radiographs. Bone marrow oedema & joint effusion are important MRI features associated with inflammatory joint disease. Synovial membrane inflammation and hypertrophy are detected after contrast enhancement[107].

MRI is able to visualize synovium located deep within joints such as the hip without being obscured by bony structures. Contrast enhanced MRI generally improves tissue visualization & clearly differentiates inflamed synovium from joint effusion[108].

In this study joint effusion was identified in all the 6 (100%) patients with osteoarthritis, synovial thickening was identified in

5 (83.3%) patients, bone marrow edema in 4 (66.7%) patients, subchondral cysts in 2(33.3%) patients, joint space narrowing in 3 (50%) patients, marginal osteophytes in 4 (66.7%) patients and soft tissue edema in 2 (33.3%) patients, and the sensitivity of MRI in diagnosis of osteoarthritis was 83.3%.

Transient osteoporosis of the hip (TOH) is a rare self-limiting condition that typically affects middle-aged men or, less commonly, women in the third trimester of pregnancy. These individuals present without a history of major trauma but usually developed an acute onset of hip pain accompanied by decreased ranges of motion, and a limping gait[109].

MRI is the most sensitive and specific imaging technique for detecting transient osteoporosis. MRI shows decreased signal intensity of bone marrow on T1-images and increased signal intensity relative to the intensity of normal marrow on T2-images. Joint effusions are seen on T2-images[110].

Marrow edema of femoral head and neck was identified in MRI scan in all the 4 (100%) patients, as diffuse low signal on T1 weighted images and high signal on T2 and STIR weighted images.

MRI helps to distinguish TOH from other conditions that include avascular necrosis, cancer, stress fracture of neck of femur, septic arthritis, soft tissue injury, radiculopathy, infiltrative marrow process and inflammatory joint diseases[111].

Balakrishnan et al.[112] reported that MRI shows a diffuse edema pattern common to both AVN & TOH, but the absence of focal defects and subchondral changes is highly suggestive of TOH.

In our study, out of 4 patients who were diagnosed as migratory osteoporosis, MRI findings were true positive in 3 patients. The diagnosis was confirmed by clinical and follow up MRI scans after conservative treatment and the disease was self limited, there was 1 false positive patient misdiagnosed as migratory osteoporosis by initial MRI and on follow up after one month, MRI revealed femoral head avascular necrosis. So the sensitivity of MRI in diagnosis of migratory osteoporosis was 75%.

Septic arthritis is a common disabling disease that requires early diagnosis for optimal outcome. Any delay in diagnosis of septic arthritis may increase morbidity and lead to complications such as bone and cartilage destruction, osteonecrosis, secondary osteoarthritis, osteomyelitis, and eventually ankylosis[113].

In our study, The dominant MRI finding was joint effusion which was identified in all the (100%) patients, followed by synovial thickening that was identified in (75%) patients, enhanced synovium in (75%) patients and soft tissue edema in (50%) patients.

Synovial inflammation and effusions are readily demonstrated with MR imaging using T2 or inversion recovery sequences and are the earliest finding in septic arthritis. The superior soft tissue resolution of MR imaging clearly demonstrates the distribution of fluid in the joint space, associated bursae, and synovial cyst formation. Involvement of surrounding muscle and tendons, as well as abscess and sinus tract formation are well delineated[114].

In our study, Out of the 4 patients who were diagnosed as, septic arthritis. MRI findings were true positive in 3 patients.

The diagnosis was confirmed by clinical and laboratory investigations, (ESR,CRP&TLC) and ultrasound examination confirming the presence of joint effusion. One false positive patient misdiagnosed as septic arthritis, there was no evidence of infection and on follow up clinically and by ultrasound was diagnosed as transient synovitis. The sensitivity of MRI in diagnosis of septic arthritis was 75%.

Developmental dysplasia of the hip is the most common cause of an unstable hip in pediatric population. Left hip is more commonly involved (40 to 60% of cases) with bilateral involvement in 20%. Magnetic Resonance Imaging (MRI) plays an important role in the early detection as well as in the evaluation of various soft tissue obstacles that can cause hindrance in reduction. Preoperative MR imaging also helps in determining the acetabular labral coverage which further guides the orthopaedic surgeon in planning the management[(114)].

MR imaging has numerous advantages over radiography particularly in looking for the ossified femoral nucleus as well as in better demonstration of morphology of the acetabular dysplasia in single examination with lack of ionizing radiation. Also with the proper use of sequences, arthrogram like image can be produced. MR is also used to detect the immediate and delayed post operative complications[(115)].

Out of the 5 patients diagnosed as developmental dysplasia of the hip, MRI findings were true positive in all 5 patients. The diagnosis was confirmed by complementary X-ray and US examination of the affected hip and follow up by clinical and radiological assessment after treatment. So, the sensitivity of MRI in diagnosis of DDH was 100%.

MRI improves detection and characterization of acetabular deficiency. MRI can also assess the hip joint for potential associated injuries to the articular cartilage, labrum, and the ligamentum teres[88].

In our study, The dominant MRI finding was location of femoral head superior to the acetabulum which was identified in all the 5 (100%) patients, followed by irregular shape and shallow acetabulum in 4 (80 %) patients, Labral tears in 2 (40%) patients and degenerative joint disease in 2(40%) patients.

Legg-Calvé-Perthes disease (LCPD) is idiopathic osteonecrosis (osteochondrosis) of the immature capital femoral epiphysis. It occurs in as many as 0.016% of children 2–14 years old, with a peak incidence at 5–6 years old. Boys are 5 times as likely as girls to be affected, and 85–90% of cases are unilateral. Presenting symptoms include limp and pain in the hip, thigh, or knee[116].

The role of MR imaging in the evaluation of Legg-Calvé-Perthes disease varies according to the severity and duration of the disease. In early LCPD, when radiographs are normal, the role of MR imaging is to detect the presence of ischemic marrow. In more advanced LCPD, MR imaging can demonstrate the extent of marrow involvement, the degree of cartilaginous or synovial hypertrophy, and the extent of epiphyseal and metaphyseal cartilaginous abnormalities[117].

MR imaging of LCPD has been shown to be more accurate in evaluating the extent of epiphyseal necrosis and can be used to stage the hip and identify when the revascularization period begins. Post-contrast images accurately indicate the viable bone, which should enhance brightly post-contrast. Early enhancement

of the lateral pillar (the lateral one third of the femoral head) is consistent with a better prognosis[118].

In our study, Out of the 4 patients who were diagnosed as Perthe's disease, MRI findings were true positive in 3 patients. However, there was 1 false positive patient misdiagnosed as Perthe's disease by MRI but follow up by another MRI and X ray studies revealed that there was just marrow edema & subchondral fissure fracture. So, the sensitivity of MRI in diagnosis of Perthe's disease was 75 %.

Two MRI features predicting extensive epiphyseal necrosis were: The first is area of decreased signal intensity on both T1W and T2W images covering over two thirds of the epiphysis, and the second is diffuse bone marrow oedema of the femoral neck and metaphysis[119]. This goes with our study in which dominant MRI finding was femoral epiphyseal distortion (irregular shape, small size, fragmentation) which was identified in all the 4 (100%) patients, followed by abnormal signal intensity of femoral epiphysis in 3 (75%) patients, bone marrow edema in 3 (75%) patients and joint effusion in 2(50%) patients.

MRI can be used to depict and characterize several of the most important complications of Legg-Calvé-Perthes disease. Although it is estimated that approximately 60–70% of hips affected by LCP disease heal spontaneously without functional impairment at maturity, a considerable number of affected hips become painful later in life, with many eventually requiring arthroplasty[75].

Premature degeneration (secondary osteoarthrosis) of the hip joint is far and away the most common complication observed in healed Legg-Calvé-Perthes disease. Abnormal contour of the

femoral head leads to repulsion between articular cartilage surfaces, promoting premature degeneration. Premature hip joint degenerative changes may be observed as early as the second or third decades of life in individuals affected by Legg-Calvé-Perthes disease and are well depicted by MRI. MRI findings include abnormal joint space narrowing, with thinning of femoral head and acetabular articular cartilage as well as subchondral cyst (geode) and osteophyte formation[75].

Slipped capital femoral epiphysis (SCFE) is a typical disease of puberty with a reported prevalence of up to 10 per 100,000. Although it's etiology is unknown, the condition may be associated with biomechanical factors, such as obesity, increased femoral retroversion, and increased physeal obliquity, or with endocrine disorders such as hypothyroidism and hypogonadism[120].

The most frequent presenting complaints are pain in the affected hip, groin, thigh or knee, alteration in hip range of motion and often a gait abnormality. Symptoms may be very mild, even allowing patients to be active and play sports, or so severe that it prevents joint movements[121].

The diagnosis of SCFE can also be difficult.Some patients may present without a limp and may complain of a pain in the knee rather than the hip. Delay in diagnosis of SCFE is a common problem, in some series when the patient's chief complaint is knee pain the missed diagnosis rate is 100%[122].

Morphologic distortion of the physis, bone marrow edema within the metaphysis and epiphysis, and joint effusion were the preoperative MRI findings of SCFE. MRI also allows for accurate

evaluation of the femoral head vascularization before and after surgery in children with SCFE[123].

In our study, Out of the 3 patients diagnosed as slipped capital femoral epiphysis, MRI findings were true positive in 2 patients. However, there was 1 false positive patient misdiagnosed as slipped femoral capital epiphysis & it was proven to be hip sub-luxation. So, the sensitivity of MRI in diagnosis of slipped femoral capital epiphysis was 66.7%.

Dillon et al.[123] reported that MRI provides an early and sensitive method for detecting the pre-slip stage of the proximal femoral epiphysis and the earliest evidence of slipped capital femoral epiphysis on MRI is diffuse or globular epiphyseal widening and hyperintense signal of the bone marrow along the epiphysis on T2-weighted images which indicate stress and edema. This goes with our study which shows that the dominant MRI finding was widening and displacement of the femoral epiphysis which was identified in all the 3(100%) patients, followed by focal subchondral signal abnormality that was identified in 2 (66.7 %) patients, bone marrow edema in 1 (33.3 %) patients and joint effusion in 2(66.7%) patients.

Subchondral stress fracture of the femoral head has been attributed to insufficiency fracture associated with poor bone quality in the elderly population or as a fatigue fracture in young military recruits. When it occurs in young military recruits, it is usually secondary to increased activity levels[124].

Subchondral insufficiency fracture of the femoral head (SIFFH) is typically seen in the anterosuperior portion of the femoral head corresponding to the weight bearing surface[125].

SIFFH is characterized by acute onset hip pain, without over trauma, that often progressively worsens over time. SIFFH may be associated with joint space narrowing, either at the onset in the setting of an arthritic hip, or with progressive subchondral collapse related to the fracture insult[126].

There are often no apparent lesions to the femoral head on plain radiography. Diagnosis with T1-weighted magnetic resonance image (MRI) is made by identification of an irregularly shaped, low-intensity band parallel to the subchondral bone, often with associated bone marrow edema[126].

Ikemura S. et al.[127] suggest that the shape of the low-intensity band on MRI is useful for the differentiating subchondral insufficiency fracture from osteonecrosis. In subchondral insufficiency fracture the band is generally irregular, serpiginous, convex to the articular surface, and often discontinuous. In contrast, in osteonecrosis, the low-intensity band is generally smooth and circumscribes all of the necrotic segments, with concavity to the articular surface.

In our study, Out of the 2 patients diagnosed as stress fractures, MRI findings were true positive in the 2 patients and the dominant MRI finding in patients with subchondral stress fractures was bone marrow edema in the 2 (100 %) patients, also femoral head subchondral linear hypointense line in the 2(100 %) patients and joint effusion in 1 (50%) patient. So the sensitivity of MRI in diagnosis of stress fractures was 100%.